Achieving Integration on Capital Projects with Enterprise Resource Planning Systems

James T. O'Connor and Steven C. Dodd
Civil Engineering, The University of Texas at Austin
jtoconnor@mail.utexas.edu

Introduction

Businesses of every type have come to the conclusion that integration of information systems is a must for optimization of operations and maximization of profits. How to accomplish such integration, however, remains an elusive search for many, especially those involved in delivery of capital facilities. ·

In simple terms, integration, in the context of this paper, is essentially the ability of two or more information systems to efficiently exchange information in such a way as to maximize the transfer of useful knowledge. As a brief example, it is highly desirable to be able to link facility geometry data with a work breakdown structure that can then be linked to cost breakdown structures, cost estimates, and activity schedules. To accomplish all this, the individual systems that process these separate functions would need to be effectively integrated so that data can be effectively shared .

The benefits of such integration are many. A few of the more obvious one are listed:
- Less duplication of effort
- Reduction of waste and rework
- Reduced cycle times in execution of processes and delivery of products
- Products and services of higher quality
- Reduced inventory and carrying costs
- New products, services, and markets.

This paper overviews three different approaches to integration and then focuses on one option in particular: enterprise resource planning systems. The paper then analyzes the implications applying the SAP R/3 system in managing capital projects.

Approaches to Achieving Supply-Chain Integration

Currently, owner business concerns have three basic choices for achieving widespread business information system integration:
1. Modular software systems from multiple vendors that rely on international standards.
2. Proprietary, in-house systems;
3. Enterprise resource planning systems (ERPS).

Of course, a fourth (and not uncommon) option includes bits and pieces of all three system approaches.

Relying on software systems that achieve integration through emerging and future international standard interface protocols and data structures will involve delays to integration and a high degree of uncertainty in system offerings, timing of availability, and functionality. The key advantages to this approach pertain to the expectation of a wide variety of modular software offerings at competitive prices. However, this approach is generally inadequate if one's millennium (Y2K) problem is highly threatening.

Relying on proprietary, in-house systems for integration requires a substantial capital investment and real limitations to full integration. Cost-wise, one large U.S. EPC (engineering/procurement/construction) contractor reported that the average cost of developing an interface between a commercial software package and an in-house corporate information system bus was approximately $80K. The information systems of such large EPC contractors will often entail hundreds of such software packages that need to be integrated. Regarding limitations to integration, users of such systems will have to accept the fact that they will never be able to achieve full integration with all of their future possible clients, consultants, subcontractors, or suppliers without a widespread and high degree of system conformity.

Those that plan to rely on ERP systems for widespread integration will have to accept both the high cost of investment and the lack of customization associated with such systems. While a variety of such systems are available, a "one size fits all" mentality exists among ERP vendors and results in a "take it or leave it" circumstance for the customer. Certainly the key advantages are that these systems offer a high degree of integration *now* and are well supported in training and system implementation consulting. In addition, these systems can also readily solve an organization's Y2K challenge.

A unique disadvantage with pursing capital facilities delivery integration with ERP systems is that these systems have evolved primarily from an accounting/finance/sales paradigm for the manufacturing and services business sectors. Thus,

application of these systems within the domains of engineering and facility project management often reflects a procurement and/or mass-assembly mindset, not one of developing a unique project for a unique client on a unique site.

Focus on ERP & SAP

ERP systems have emerged as a very popular solution to information systems integration challenges among industrial owners and SAP's R/3 system is one of the most popular of all. A recent straw poll among Construction Industry Institute (CII) member company representatives indicated that SAP R/3 is the overwhelming system of choice among these large manufacturers. Accordingly, owner project management executives are keenly concerned about the implications of ERP systems, and SAP R/3 in particular, on the delivery of capital facilities.

While thorough coverage of R/3's functionality is beyond the scope of this paper, Figure 1 provides an overview of major functional components of the system.

As stated earlier, it is important to recognize that ERPS functionality has been fundamentally driven by the needs of operational concerns, such as manufacturing, sales, or providing some service. Managing a facility development project has certainly been lower in the hierarchy of functionality.

However, given the functional overlap that does exist between facility development and facility operations (such as asset management), and given the dominance of ERPS systems in managing corporate operations, it is logical to consider extending the ERPS functionality forward in the facility life-cycle toward the facility development process.

In addition, SAP certainly has envisioned an expanded scope for its R/3 system into the domain of capital facilities delivery. In fact, a recent presentation by SAP executives recognized that the engineering and constuction sector (E&C) may represent more than 10% of its future market. Thus, without doubt, E&C is a targeted sector among ERP vendors.

These facts are significant not only in the implications for owner project management groups and their work processes, but also for the contractors and suppliers who serve these owners. There is a reasonably strong perception that owners' approaches toward achieving integration will, in large part, drive or establish how their contractors and suppliers achieve integration.

With all this as a backdrop, a study of R/3 and its implications on capital facilities delivery was undertaken. Three components of the study are summarized in the remainder of this paper. These include 1) the results of a functional gap analysis of the R/3 system; 2) the results of a pre-forum satisfaction survey of "power users"; and 3) a summary of some of the findings developed during an Owner's Forum conducted in September 1998.

Project Execution Functional Gap Analysis

A functional gap analysis was conducted on R/3 versions 3.0 to 3.1 for the purpose of determining which capital facility project execution functions are not serviced directly by the R/3 system. This was done by initially identifying 54 different functions which are common to most capital facility projects.

Out of a total of 54 functions analyzed, the following 8 project functions were 1) found to have a high need for inclusion in the integrated information system, but 2) are NOT provided by R/3:

- Existing facility configurations
- Schematic facility configurations
- Detailed design configurations
- As-built configurations
- Technical specifications
- Physical interference detection
- Facility walk-through simulation
- Equipment selection & scheduling assistance

The omission of facility configuration data-related functions within R/3 is significant, given the importance of this data to follow-on developments such as cost estimates, activity schedules, and even facility operations models. However, it can also be argued that these are functions that lump-sum turnkey contractors can develop and manipulate in relative isolation to owners, and that any needs for data transfer to owners can occur in an infrequent, discrete mode.

Beyond these eight, an additional 15 capital project functions were characterized as provided by R/3, but deficient in some way and/or to some extent. These deficiencies pertain to the following functionalities:

- Unit price tracking
- Job cost reports
- Labor cost reports & workhour forecasting
- Change order cost tracking
- Work breakdown structure model
- Project conceptual/milestone schedule
- Detailed activity precedence network
- Project schedule reports
- Short interval planning
- Purchase order development & issuance
- Monitoring of change orders, rework, and back-charges
- Management of contractor retainage
- Tracking & documenting percentage of physical completion

- Field warehouse inventory management
- Warehouse inventory reorder processing

It is believed that the significance or seriousness of these deficiencies will vary with different organizations' varying business processes.

On the positive side, the gap analysis indicates that 31 of the 54 functions assessed (57% of all) are adequately or even fully served by R/3. This is good news, given that this kind of system integration has otherwise largely remained an elusive, unachieved goal.

On the issue of functionality gaps and needs for system supplementation, SAP has entered into alliance agreements with other software vendors for the purpose of addressing some of these deficient functionalities. For the E&C sector, notable alliance vendors (and their system scope) include the following:
- Documentum (document management)
- Intergraph/Bentley (CAD, configuration models)
- Autodesk (CAD, configuration models)
- Primavera (schedule management)
- Microsoft (schedule management)

It should be noted that R/3's Document Management System is a critical module for allowing some degree of integration with documents otherwise generated and processed with alliance vendor (non-R/3) software. Of course, the key concern on this issue is the extent of the link or degree of knowledge/data transferable via the link. The details of this issue are beyond the scope of this paper.

Survey Results

Six "power users" of SAP R/3 on capital facility projects were surveyed regarding system beneficial impacts and aspects of the system they were most and least satisfied with.

These six users, on average, reported a "moderate" degree of to-date overall improvement to execution as a result of the system. They also reported that they *ultimately* expect a "high" degree of improvement to their work processes.

These six power users were most satisfied with the following aspects of the R/3 ERP system:
- General ledger & cost control
- Project cost management
- Procurement & materials management
- Schedule management
- Schedule integration with cost and finance data
- Integration between materials management, procurement, and fixed asset accounting/ management

- Resource planning and availability control
- Integration between application modules

These same six users were least satisfied with the following aspects of the R/3 ERP system:
- Inability to forecast additional costs
- Schedule management function that is too cumbersome
- Construction planning & analysis
- Plant maintenance functions for maintenance personnel
- Configuration documentation
- Quality control procedures & documentation
- Subcontractor management
- Safety management
- Ability to establish performance & % complete based on physical progress
- Keeping pace with new releases
- Higher-than-expected implementation costs
- Integration with non-SAP applications

Owner-Contractor Integration Needs

Two of the three break-out discussion groups at the Owner's Forum focused on owner needs for data from ECP contractors. These needs for data were sorted into two categories:
- Needs for data during the project
- Needs for data at the transition from construction to operations

The specific needs Owners have for data during the project include the following:
- Original planned cost
- Current cost forecast
- Current actual cost, including commitments
- Integrated current EPC schedule
- Original planned contractor manpower loading curve
- Current actual contractor manpower loading curve
- Originally planned Percent Physical Complete schedule
- Current actual Percent Physical Complete schedule
- Physical plant configuration data: at both approved-for-design and approved-for-construction milestones
- Logical plant configuration data: at both approved-for-design and approved-for-construction milestones
- Details of the digital control system (DCS)
- Current status of operator training
- Current data on construction safety incidents
- Project correspondence
- Project submittals
- Change orders

The specific needs Owners have for data at the transition from construction to operations include the following:

- Asset cost data and depreciation data
- Asset warranty data
- Manufacturing operations instructions & documentation
- Maintenance plan, including the spare parts plan
- Operations performance targets
- Actual operations performance levels
- Final, as-built physical plant configuration model
- Final, as-built logical plant configuration model
- Operational safety, health, & environmental performance data, including material safety data sheets
- Other regulatory data, such as permit data, etc.

These needs for information represent important guidance to system developers on the fundamental needs and opportunities for integration between industrial owners and EPC contractors. Software developers should recognize that *owners don't need all the data that is contemporaneously available,* which an ERP system tends to provide and which can (and does) overwhelm and confuse users. Owners only need that data that they can use, and the ideal system should accommodate this.

Figure 2 may be useful in better understanding both *inter-*organizational system integration and *intra-*organizational integration within capital facility delivery.

Needs for System Improvements

The third Forum break-out group focused on needs for improvement within R/3 in the context of capital project execution. These needs were classified as either user issues or functional issues and are listed below:

User Issues:
- Slow user learning curve
- User-friendliness for the occasional user; consider a "PS (Project System) -lite" for the occasional user
- Add Excel-like functionality where appropriate
- Use more project management (and less accounting) terminology where appropriate

Functional Issues:
- Alternative calendar formats in the PS module
- Resource leveling on single projects
- Easy links to estimating programs
- Financial accounting options for projects

Of course, everyone has their preferred software systems, whatever the system purpose and everyone

would like their ERP system to have these "best of breed" characteristics and capabilities. While systems can always be improved upon, the perfect system will, no doubt, remain an illusion.

Overview of SAP R/3 Planned Improvements

In fairness to SAP, it is very important to recognize that R/3 releases 4.0 and 4.5 will have many improvements that will impact the way capital facility projects will be executed and some that will address the concerns itemized above. Some particularly noteworthy improvements are described below:

- Transfer Pricing enables materials movement to be evaluated uniquely for different profit centers
- Capital Investment Programs process capital project requirements for simplified planning, decision-making, and approvals
- Available-to-Promise provides information on products and resources for accurate deliveries
- Improved subcontractor integration functionality
- Improved procurement functionality through web-based catalogs
- Enhanced warehouse management functionality
- Increased outsourcing interface functionality
- New lead time simulation functionality
- Simplified document handling features; with stronger interface between document management and project system modules
- Trend analysis of schedule milestones;
- Increased project cost forecast functionality;
- Added functionality pertaining to environmental, health, and safety data management;
- Increased functionality pertaining to engineering change management;
- Increased functionality pertaining to project bill of materials;
- Increased planning functionality pertaining to maintenance activities;
- Enhanced processing of price quotes;
- Workforce planning enhancements; and
- Enhancements pertaining to monitoring and expediting procurement.

Conclusions

Process integration for capital facilities delivery is being pursued in many different ways by many different organizations.

A popular approach toward overall corporate integration among industrial manufacturers is to

implement an enterprise resource planning system, such as SAP's R/3 system.

Among owner project management professionals and their contractors and suppliers, and pertaining to their respective work processes, there has been a significant amount of concern regarding the implications of owner-driven ERP systems. This concern, in part, is driven by the fact that ERP systems have, for the most part, been developed with an accounting/finance/manufacturing/sales paradigm. Thus, work process adjustments will no doubt be required and comfort levels will be sacrificed, at least in the short term.

This paper has itemized many ways in which the SAP R/3 system (and similar ERP systems) can (and need

to) be improved upon in order to better serve a sizable potential market: the E&C sector.

It will certainly be interesting to see how these integration efforts continue to unfold in the future and how the emergence of international standard interface protocols and data structures will change the integration landscape.

References

Dodd, Steven C., *Enterprise Resource Planning Software Systems and Capital Facilities Delivery*, M.S. Thesis, The University of Texas at Austin, May 1999.
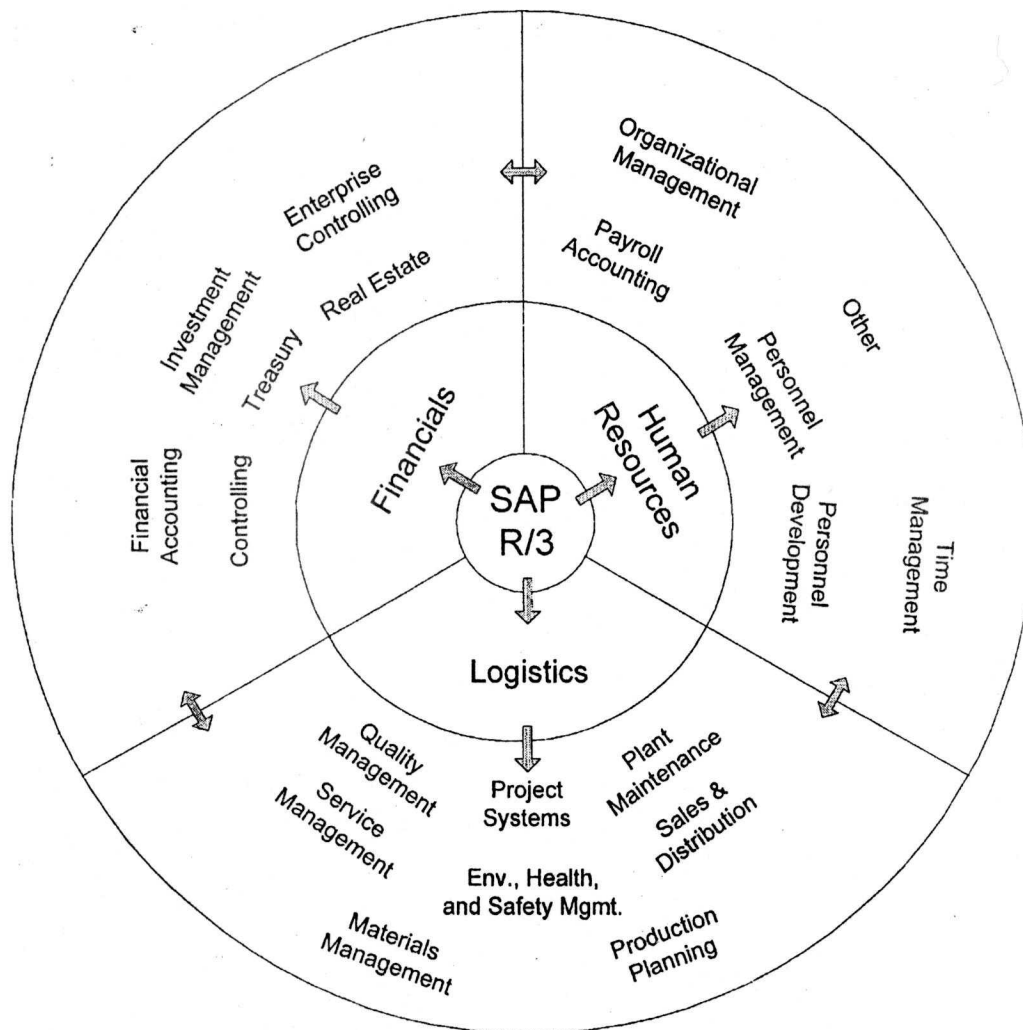
Figure 1: SAP R/3 Breadth of Coverage

Capital Project Process Phases

F E L $\Rightarrow$ E-P-C $\Rightarrow$ S - U $\Rightarrow$ O / M
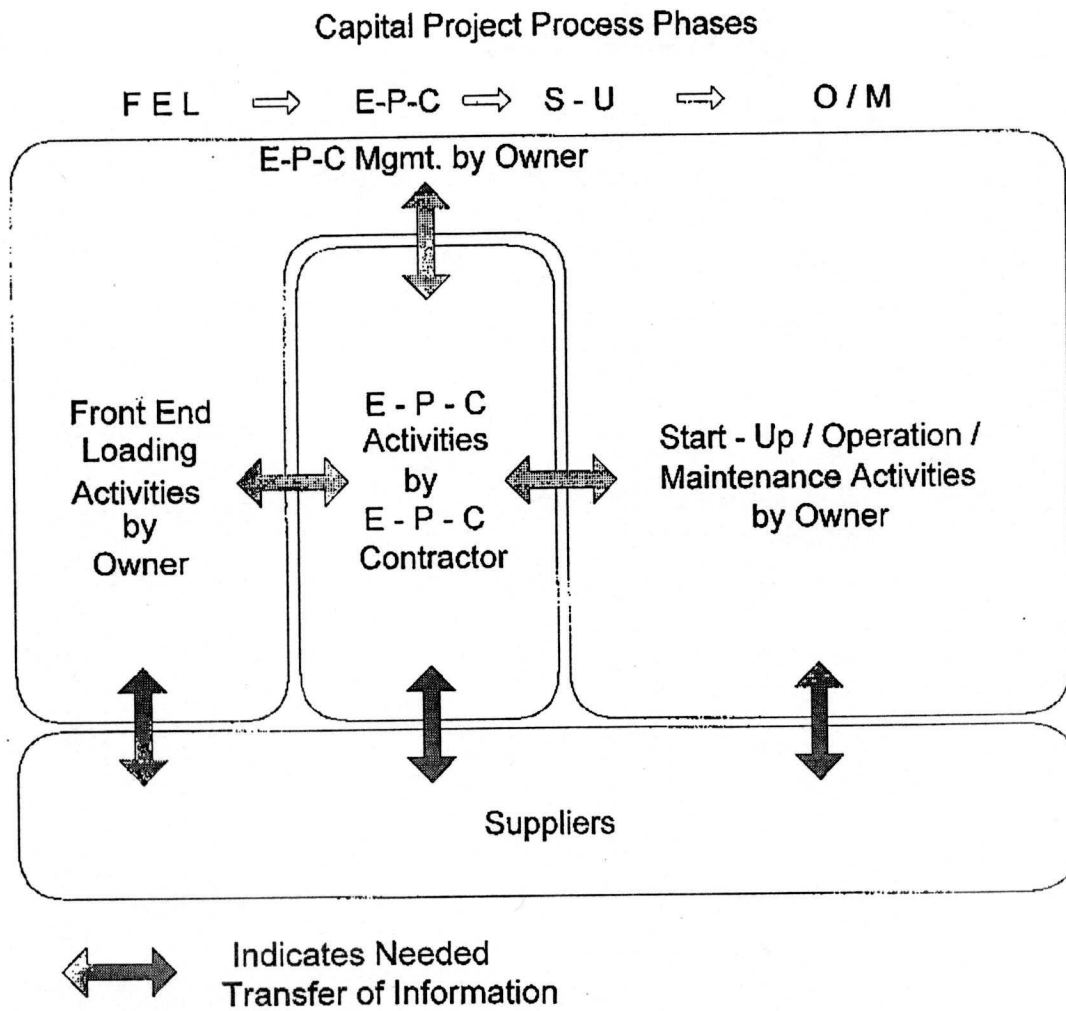

Figure 2: Inter- and Intra-Organizational Needs for Integration within Capital Facilities Delivery